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D. Remarks

Rejection of Claim 1 Under 35 U.S.C. §103(a), based on U.S. Patent No. 5,893,740 (Hsue) in view of U.S. Patent No. 5,893,740 (Chang et al.).

5 The invention of amended claim 1 is directed to a method that includes forming a contact hole through a first insulating layer that is self-aligned with respect to a transistor gate. The transistor gate has a gate length less than 0.2 microns. Further, the contact hole is formed without forming a contact hole etch stop liner. The method also includes forming the contact hole by reactive plasma etching through the first insulating layer that comprises non-densified
10 doped silicon dioxide.

As is well understood, to establish a prima facie case of obviousness, a rejection must meet three basic criteria. First, there must be some suggestion or motivation to modify a reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference(s) must teach or suggest all claim limitations.

15 The cited combination of references does not show or suggest reactive plasma etching through a first insulating layer comprising a non-densified doped silicon dioxide, as recited in claim 1.

It is admitted that *Hsue* does not show a first insulating layer comprising a doped silicon dioxide, as set forth in claim 1. However, such a limitation is not show or suggested by *Chang et al.*, either. *Chang et al.* provides no teachings regarding a first insulating layer¹ as set forth in
20 claim 1, and so cannot suggest a doped first insulating layer.

Accordingly, because the cited combination of references does not show or suggest all limitations of claim 1, a prima facie case of obviousness cannot exist based on *Hsue* in view of *Chang et al.*, and this ground of rejection is traversed.

25 In addition or alternatively, Applicants' note that if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.² As argued in Applicants' previous Response to Office Action, because the combination of *Hsue* in view of *Chang et al.* would

¹ See *Chang et al.*, all figures, which show no layers above a gate and sidewall layer.

² *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984).

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render the reference *Hsue* unsatisfactory for its intended purpose, the motivation relied upon in rejecting claim 1 is not sufficient to sustain a prima facie case of obviousness.

The reference *Hsue* teaches a self-aligned contact (SAC) process. As shown in *Hsue*, a self-aligned contact is a contact formed adjacent to a conductive structure. The contact remains electrically isolated from the gate or conductive structure by insulating sidewalls and a top
5 insulating layer.³ This was also noted in Appellants' Specification.⁴

Chang et al. is not compatible with the *Hsue* process. *Chang et al.* teaches a short channel field effect transistor that does not include an insulating or dielectric layer formed on the top of the gate.⁵ Incorporating the transistor of *Chang et al.* into the *Hsue* process would defeat
10 the SAC process, as no structure would exist to prevent the gate from being exposed when the contact hole is etched. That is, there is no structure over the top of the gate that would insulate the conductive gate from a subsequently formed conductive contact. Thus, modifying *Hsue* to include the short-channel gate structure of *Chang et al.* would render the reference *Hsue* unsatisfactory for its intended purpose of a self-aligned contact.

15 For this additional reason, this ground of rejection is traversed.

Rejection of Claims 2 and 4-11 Under 35 U.S.C. §103(a), based on *Hsue* in view of *Chang et al.*, and further in view of U.S. Patent No. 5,468,342 (*Nulty et al.*).

Claim 1 has been amended to include the limitations of claim 2, thus the limitations of
20 claim 1 will be addressed in these remarks.

As noted above, amended claim 1 recites forming a contact hole through a first insulating layer comprising non-densified doped silicon dioxide. Such a contact hole is formed "without forming a contact hole etch stop liner".

Such a limitation is not shown or suggested by the cited combination of references.

25 While *Hsue* shows the formation of a contact hole, such a contact hole is through an undoped silicon dioxide.⁶ The second reference, *Chang et al.*, provides no teachings regarding an

³ See *Hsue*, FIG. 1F, where a conductive contact 28 is isolated from gates 12 by insulating sidewalls 18 and top insulating layer 14.

⁴ See the Specification, page 4, lines 7-10.

⁵ See *Chang et al.*, FIGS. 1(b) and 3(b), which show a silicide layer formed on the top of the gate electrode. No dielectric layer is formed on the gate.

⁶ See *Hsue*, FIGS. 1D and 1E and Col. 2, Lines 4-16, which describes forming a SAC contact opening through (undoped) SiO₂ layer 21.

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insulating layer, as noted above in the remarks regarding *Hsue* in view of *Chang et al.*

To show a non-densified doped silicon dioxide layer, the rejection relies on the "Background of the Invention" set forth in *Nulty et al.*⁷ However, this portion of *Nulty et al.* teaches away from Applicants' claim 1 limitation of "without forming a contact hole etch stop liner". In the "Background of the Invention" of *Nulty et al.* an etch stop layer is included in the formation of an opening (e.g., contact).

As shown, structure 404 is covered by silicon nitride etch stop layer 403.⁸

As is well known, prior art references must be read as a whole and consideration must be given where the references diverge and teach away from the claimed invention.⁹ Further, as is also well established, a prima facie case of obviousness may be rebutted by showing that the art, in any material respect, teaches away from the claimed invention.¹⁰ Because the Background of the Invention set forth in *Nulty et al.* shows utilization of an etch stop layer, such a teaching teaches away from Applicants' claim 1 limitation of "without an etch stop layer", and thus rebuts any prima facie case of obviousness.

Accordingly, this ground of rejection is traversed.

Various claims depending from claim 1 include additional limitations not shown in the cited references.

Claims 4-11 all depend from claim 3. Claim 3 includes the particular dopant limitation of a concentration of phosphorous that is greater than 5% by weight. Applicants reiterate that none of the references cited for this ground of rejection (*Hsue*, *Chang et al.*, *Nulty et al.*) discloses a particular phosphorous percentage limitation. Applicants respectfully request a citation to any of *Hsue*, *Chang et al.*, or *Nulty et al.* that shows any particular phosphorous percentage teachings.

In responding to Applicants' previous arguments, the Final Office Action apparently cites the reference U.S. Patent No. 5,661,064 (*Figura et al.*). This is not a cited reference for this ground of rejection. If claims 4-11 are being rejected based on *Hsue* in view of *Chang et al.*, further in view of *Nulty et al.*, and even further in view of *Figura et al.*, this represents a new

⁷ See the Office Action, dated 3/25/03, Page 3, Line 18 to Page 4, Line 2.

⁸ *Nulty et al.*, Col. 3, Lines 50-51, emphasis added.

⁹ *Azko N.V. v. United States Intl' Trade Comm'n*, 1 USPQ2d 1241, 1246 (Fed. Cir. 1986).

¹⁰ *In re Geisler*, 43 USPQ2d 1362, 1366 (Fed. Cir. 1997).

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ground of rejection, and thus any final rejection of these claims is premature, and should be reinstated as a new ground of rejection.

Applicants respectfully request clarification as to the basis for rejecting claims 4-11. In particular, Applicants request clarification as to whether these claims are now being rejected also
5 based on *Figura et al.* If claims 4-11 are being newly rejected based on *Hsue, Chang et al.*, *Nulty et al.* and newly cited *Figura et al.*, please consider this request for reconsideration to establish right of petition on this matter.

10 Rejection of Claim 3 Under 35 U.S.C. §103(a), based on *Hsue* in view of *Chang et al.* and further in view of *Figura et al.* (U.S. Patent No. 5,661,0642).

Claim 3, which depends from claim 1, adds that forming a contact hole includes reactive plasma etching through a first insulating layer comprising silicon dioxide having a concentration of phosphorous dopant that is greater than 5% by weight.

To the extent that this ground of rejection relies on the combination of *Hsue* in view of
15 *Chang et al.*, the comments set forth above for claim 1 are incorporated by reference herein. Namely, that motivation for such a combination is believed to be lacking, thus a prima facie case of obviousness has not been established.

In addition or alternatively, Applicants must reiterate previous arguments regarding this claim. The motivation relied upon for adding *Figura et al.* to the combination is set forth below.

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Figura teaches a silicon dioxide material, such as borophosphosilicate glass (BPSG) having a phosphorous dopant from 1 to 10%... It would have been obvious... to modify *Hsue* in view of *Chang* by implanting silicon dioxide with a phosphorous dopant that is greater than 5% for the purposes of enhancing the
25 conductive properties of an intrinsic insulative material such as SiO₂.¹¹

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This is not the motivation set forth in *Figura et al.* *Figura et al.* does not dope an insulating layer to "enhance its conductive properties". Such a doping is to enhance the conductive properties of an adjacent container member. This is clear from the text of *Figura et al.*

¹¹ See the Office Action, dated 3/25/03, Page 5, Lines 4-10, emphasis added.

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After the selective etching, first and second container members 34 and 35 are conductively doped to an average dopant concentration of greater than about 5×10^{19} ions/cm³... Such doping can be accomplished by ion implantation or heat diffusion using an appropriate diffusion gas. Alternately, molding layer 16 can be provided to a sufficiently high phosphorus or other conductivity impurity doping concentration (i.e., from 1%-10%) such that the doping includes out-diffusing conductivity enhancing dopant impurity from molding layer 16 into first container member 34.¹²

From the above, it is clear that a BPSG layer is doped, not to increase its own conductivity, but instead to increase the conductivity of an adjacent layer of silicon by out-diffusion. Thus, *Figura et al.* never teaches enhancing the conductive properties of an intrinsic insulative material. Accordingly, the rationale relied upon in the rejection is not an objective teaching from the prior art.

The rationale is not believed to be general knowledge, either. The rationale teaches a contradictory goal – increasing the conductivity of an insulating layer. As is well understood an insulating layer provides insulation by being non-conductive. Known rationales for doping an insulating layer are discussed at length in Applicants' Specification (e.g., preferential gettering and flow properties), and do not include seeking to increase the conductivity of an insulating layer.¹³

For all of these reasons, the rejection of claim 3 is traversed.

Rejection of Claim 12 Under 35 U.S.C. §103(a), based on *Hsue* in view of *Nulty et al.*

The invention of amended claim 12 recites a method that includes forming a first insulating layer comprising a high density plasma silicon dioxide having a concentration of phosphorous that is greater than 5% by weight. The method also includes etching a contact hole through a first insulating layer that is self-aligned with respect to a conductive structure. The conductive structure is formed over a substrate and includes insulating sidewalls. The etching is performed with particular etch selectivity parameters. The etch selectivity between the first

¹² *Figura et al.*, Col. 4, Lines 49-60, emphasis added.

¹³ See the Specification, Page 6, Line 9 to Page 7, Line 18.

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insulating layer and the sidewall is greater than ten to one. The etch selectivity between the first insulating layer and substrate is greater than one hundred to one.

To the extent that amended claim 12 includes the limitation of "phosphorous that is greater than 5% by weight", Applicants incorporate by reference herein the comments set forth above for claims 2 and 4-11. Namely, that neither *Hsue* nor *Nulty et al.* discloses a particular phosphorous percentage limitation. Thus, Applicants' range of greater than 5% by weight cannot be shown or suggested by such references.

Still further, Applicants reiterate that the stated grounds for rejection appear based on an erroneous interpretation of the reference *Hsue*. The rejection relies on the following reasoning:

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Since *Hsue* etches and uses the same method of etching a contact hole through a first insulating layer... as that of the claimed invention, then using *Hsue*'s method would inherently result in an etch selectivity between the first insulating layer and the sidewall that is greater than ten to one, and an etch selectivity between the first insulating layer and substrate that is greater than one hundred to one.¹⁴

15

As noted in previous responses, the method of etching shown in *Hsue* is not the same as Applicants' claimed 12. Claim 12 clearly recites etching a contact hole through a doped silicon dioxide. The etch of *Hsue*, is directed to un-doped silicon dioxide.¹⁵ Thus, the cited reference does not show the same materials as Applicants' claimed invention, and so cannot inherently obtain the same etch selectivities, as argued.

20

Because the etch selectivities recited in claim 12 are not inherent in the method of *Hsue*, all limitations of claim 12 have not been shown or suggested by the cited reference. Accordingly, this ground of rejection is traversed.

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Rejection of Claim 13 Under 35 U.S.C. §103(a), based on *Hsue* in view of *Nulty et al.*, and further in view of *Chang et al.*

To the extent that this ground of rejection relies on the combination of *Hsue* in view of *Nulty et al.*, Applicants incorporate by reference herein the comments set forth above for claim

¹⁴ See the Office Action, dated 3/25/03, Page 5, Line to Page 6, Lines 1-4.

¹⁵ See *Hsue*, Col. 2, Lines 3-5 and Col. 4, Lines 19-22, which describe silicon dioxide layers 21 and 46, with no indication of doping.

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12. Namely, that the combination of references does not show all limitations of base claim 12, and the motivation relied upon is lacking.

5 Rejection of Claim 14 Under 35 U.S.C. §103(a), based on Hsue in view of Nulty et al., and further in view of Chang et al.

Claim 12 has been amended to include the limitations of claim 14. Thus, the limitations of claim 12 will be addressed here.

To the extent that this ground of rejection relies on the combination of *Hsue* in view of *Nulty et al.*, Applicants incorporate by reference herein the comments set forth above for claim 12.

Still further, the extent that the rejection relies on combining *Figura et al.* with *Hsue*, the comments set forth above for claim 3 is incorporated by reference herein. Namely, that the motivation relied upon is not an objective teaching from the cited art or common knowledge.

15 Rejection of Claims 16 and 17 Under 35 U.S.C. §103(a), based on Hsue in view of Nulty et al., further in view of Japanese Patent Publication 10-223897 (*Atsushi*) and further in view of Ploessl et al. (U.S. Patent No. 5,907,771).

To the extent that this ground of rejection relies on the combination of *Hsue* in view of *Nulty et al.*, Applicants incorporate by reference herein the comments set forth above for claim 12.

In addition, as is well established, if a proposed modification or combination would change the principle operation of the prior art invention being modified, the teachings of the references are not sufficient to render the claims *prima facie* obvious.¹⁶

25 *Hsue* is directed to a self-aligned contact process. Such a process exposes a substrate by etching a dielectric layer. In very sharp contrast, *Ploessl et al.* is directed to forming a trench capacitor. Such a process etches a substrate.¹⁷ Thus, to modify *Hsue* according to *Ploessl et al.* would change the contact etch of *Hsue* into a substrate etch – thereby changing the principal operation of *Hsue*.

For these reasons, the rejection of claims 16 and 17 is traversed.

¹⁶ *In re Ratti*, 123 USPQ 349 (CCPA 1959).

¹⁷ See *Ploessl et al.*, FIG. 3C and Col. 4, Lines 30-39.

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Rejection of Claim 18 Under 35 U.S.C. §103(a), based on U.S. Patent No. 5,376,562 (*Fitch et al.*) in view of U.S. Patent No. 5,776,834 (*Avanzino et al.*).

The invention of amended claim 18 is directed to a method that includes forming a hard mask comprising substantially undoped silicate glass. The hard mask is formed over an insulating layer comprising doped silicon dioxide having a doping concentration of phosphorous dopant that is greater than 5% by weight. The hard mask has openings over a contact hole location. The method further includes forming a contact hole at the contact hole location through the first insulating layer. The contact hole is formed between conducting structures that are separated from one another by less than 0.4 microns. The conducting structures have sidewalls. The contact hole is formed without forming a protective liner over the conducting structures.

A prima facie case of obviousness has not been established as the cited combination does not show or suggest all the limitations of claim 18.

The combination of references does not show a hard mask comprising substantially undoped silicate glass. *Fitch et al.* shows a method of forming vertical transistors that utilizes a mask of photoresist. While *Fitch et al.* shows two dielectric layers, such layers are never utilized as hard mask layers. Only photoresist is used as a mask.¹⁸

It is additionally noted that the term "hard mask" does not appear in the text of *Fitch et al.* Because *Fitch et al.* never shows or mentions the use of a hard mask, the reference is not believed to be suggestive of such a limitation.

The other reference *Avanzino et al.* is unrelated to contact hole formation, and so provides no teachings regarding masks, let alone hard masks.

To address Applicants' above arguments, the rejection relies on the following rationale.

Applicant traverses the rejection of claims 18 and 19... for failing to teach a hard mask comprising substantially undoped silicate glass. Applicant's argument is unpersuasive. It would have been obvious to one of ordinary skill in the art at the time of the claimed invention to form a hard mask such as undoped silicate glass over an insulating layer (See Ploessl et al., U.S. 5,907,771, column 3, lines 50, 58-

¹⁸ See *Fitch et al.*, Col. 3, Line 61 to Col. 4, Line 8. In particular see Col. 4, Lines 5-9, which shows that the opening that extends through the dielectric layers 16 and 20 is self-aligned with the (photoresist) mask opening.

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59, 62, and 63) for the purposes of forming a contact region in the semiconductor substrate.¹⁹

Thus, the Final Office Action apparently rebuts Applicants' arguments by citing *Ploessl et al.* *Ploessl et al.* is not a cited a reference for this ground of rejection. Therefore, if claim 18 is being rejected based on *Fitch et al.* in view of *Avanzino et al.*, and further in view of *Ploessl et al.*, this represents a new ground of rejection, and any final rejection of these claims is premature, and should be withdrawn.

Therefore, Applicants respectfully request clarification as to the basis for rejecting claim 18 so that appropriate petition from a premature final rejection may be taken.

If the Examiner is arguing that such a modification is "of such a notorious character that official notice" is being taken, Applicants (1) seasonably traverse such a statement and (2) request a clear statement that this the rationale relied upon. In traversing the statement, Applicants demand evidence in support of the statement, and direct attention to the comments set forth above for claims 16 and 17. Such comments note that *Ploessl et al.* is unrelated to etching contacts, and is directed to etching trenches in a substrate. Etching a substrate is an undesirable result when etching contacts.

Rejection of Claim 19 Under 35 U.S.C. §103(a), based on *Fitch et al.* in view of *Avanzino et al.* and further in view of *Figura et al.*

Applicant has amended claim 18 to include some of the limitations of claim 19. Accordingly, limitations of claim 18 will be addressed herein.

To the extent that this ground of rejection relies on the combination of *Fitch et al.* in view of *Avanzino et al.*, the comments set forth above for claim 18 are incorporated by reference herein. Namely, that the combination of references fails to show or suggest all limitations of the claim.

In addition, to the extent that the rejection relies on the motivation of "increasing the conductive properties of an intrinsic insulative material" to combine *Figura et al.*, Applicants incorporate by reference herein the comments set forth above for claim 3. Namely, that such a rationale is neither an objective teaching in the prior art, nor knowledge generally available to

¹⁹ See the Office Action, dated 3/25/2003, Page 14, Line 17 to Page 15, Line 3.

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one or ordinary skill in the art.

Claims 1, 12, 18 and 19 have been amended. Claims 2 and 14 have been cancelled. The present claims 1, 3-13, and 15-19 are believed to be in allowable form. It is respectfully requested that the application be forwarded for allowance and issue.

Respectfully Submitted,

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